Learning Objectives/Goals/ Purpose

Main Learning Objective: The learner will be able to differentiate between igneous rocks that formed intrusively in Earth's interior, and those that formed volcanically at or near Earth's surface.

Component Objectives:

- Learners will construct a model of crystallization/solidification, dependent on time, limited by melting temperature of a mineral substance.
- Learners will employ their model in the identification of igneous rock hand specimens.
- Learners will evaluate the effectiveness of their model to represent phenomenon in the natural world.
- Learners will strategize how their model could be improved to incorporate a previously a new texture (glassy, and vesicular)

Purpose: By completeing these learning objectives, students will utilize the scientific method and critical analysis of data to make an observation based model about the relationship between two or more variables in the natural world. This higher order thinking will allow the students to apply critical thinking to other aspects of Earth Science. Identification of rocks by environment of formation is a necessary skill for success on the Regents Earth Science Part D Lab Practical.

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Essential Question

What do the physical and chemical characteristics of rocks tell us about the history of the Earth?

- How does crystal size tell us about the conditions under which a rock formed?
- How does varying temperature and the rate of cooling impact the time allowed for crystallization?
- What Earth Environments allow for these different cooling rates?
- Why do the subterranean formed rocks now appear at the surface of the Earth/Mountain tops?

NYS Standards Addressed

Old Standards:

Standard 1- Analysis, Inquiry, and Design

- Key Idea 1: The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.
- Key Idea 2: Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.
- Key Idea 3: The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Standard 4:

- Key Idea 2: Major Understanding 2.1m: Many processes of the rock cycle are consequences of plate dynamics. These include the production of magma (and subsequent igneous rock formation and contact metamorphism) at both subduction and rifting regions, regional metamorphism within subduction zones, and the creation of major depositional basins through down-warping of the crust.
- Key Idea 3: major Understanding: 3.1c Rocks are usually composed of one or more minerals. • Rocks are classified by their origin, mineral content, and texture. • Conditions that existed when a rock formed can be inferred from the rock's mineral content and texture.

NGSS:

- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive processes (such as volcanism, tectonic uplift, and deposition) and destructive processes (such as weathering, subduction, and coastal erosion).] [Assessment Boundary: Assessment does not include recalling the details of the formation of specific geographic features of Earth's surface.]
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- HS. ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three dimensional model, which is controlled by mantle convection and the resulting

plate tectonics. Examples of evidence include maps of Earth's three dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.]

Materials

1. DIY digital microscope
2. Hot Plate
3. Microscope Slides
4. Salol crystals
5. Beakers & water
6. Student Ipads
7. Schoology
8. Rock Candy Examples
9. Various Igneous Rock Hand Samples
10. Rulers

Anticipatory Set/Warm Up

Teacher presents failed attempt at making rock candy for his students! Over winter break Teacher thought it would be nice to make a treat for his classes and their upcoming unit on igneous rocks. Due to a series of circumstances including but not limited to procrastination and not knowing his way around the kitchen when it comes to confections, He started process last night. He also accidentally left one sitting over the whole winter break.

What observations can be made about the two pieces of candy? Why do they have different sized crystals? How does time affect the growth of crystals?

We need to look deeper at this physical phenomenon in order to better understand it! (leads to modelling section of Instructional Process).

Instructional Process

Input: Prior to entering the room for this laboratory exercise, Learners will have been exposed to the idea that rocks (defined as being an aggregate of naturally occurring Earth material) are composed of one or more minerals (solid, naturally occurring, inorganic, crystalline objects). Learners will have experienced a sorting activity in which I ask them to sort through several hand specimens of cookies and categorize them, without giving them any indication as to which characteristics to organize them by. Learners have responded well to this activity in the past, and come up with organizational systems that are universally intuitive within the class. Past ideas have included By ingredient (i.e. Chocolate chip vs Oatmeal Raisin), and structure/formation method (i.e. Chocolate chip vs Oreo).
Learners will make the connection that both ingredient and process of making the cookie determine the classification of cookies. We then apply this analogy to rocks and minerals by stating that Rocks are "Earth Cookies" and that the ingredients for rocks are minerals. Through this analogy we begin to view Igneous rocks as a category of rocks based on process of formation, that is further subdivided by mineral content (color) and with this lesson mineral grain size.

Model:

After the crystallization demonstration, students will be asked to fill in a scaffolded system model of cooling materials with a completed
analogous system of cooling materials: i.e. Coffee cooling in a thermos vs coffee cooling spilled on. During any "downtime" while observations are being made of the crystallization of the salol solution, the teacher will review process of using the scheme for identifying igneous rocks on page 6 of the ESRT.

Checks for Understanding:

The teacher will monitor student choices for igneous rock identification, as students move between stations by both verbally questioning and digitally monitoring student work in real time through onenote on the Ipad. The teacher will also use scaffolding questions to aid the students in the initial production of the crystallization conceptual model.

Closure/Reflect

Lesson closure will involve a brief discussion of the effectiveness of our model to aid in identification, and how the model could be modified to include other textures of igneous rocks such as glassy or vesicular. 10 questions selected from recent past regents exams will be selected by the teacher, and placed on Schoology as a multiple choice "quiz" that will serve as the assessment for this learning experience. These questions will replicate the types of questions they will be asked on the end of the year assessment that require them to draw on the observational skills developed during this lesson.

Success and Measure

The standard of success and the teacher's goal for the learners is commonplace in the classroom. The teacher employs an attitude growth in the classroom and expects learners to discover their incorrect answers and incomplete ideas with the help of the teacher and or their peers if not self-evident. The goal should always be full credit on an assignment for the students. The teacher will set a goal for 80 % of the learners present will achieve a grade of 8/10 on the multiple choice assessment portion of class.

Guided Practice/monitoring

Anticipatory Set 2 Min
Demonstration 8 Min
Model Creation 6 Min
Igneous Identification Stations 10 min
Closure Discussion/Assessment 14 minutes